A DEVICE, SYSTEM, METHOD AND COMPUTER READABLE MEDIUM FOR SELECTIVELY ATTACHING TO A CELLULAR DATA SERVICE

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Related Application

This application is a continuation-in-part of U.S. Patent Application No. 09/932,180, entitled "A System, Device and Computer Readable Medium for Providing Network Services on a Mobile Device," filed on August 17, 2001, which is incorporated herein by reference.

Field of the Invention

This invention relates generally to networks.

Background of the Invention

Cellular networks, such as a Global System for Mobile Communications ("GSM") network or Universal Mobile Telecommunications System ("third-generation (3G)") network, include cellular devices, such as cellular telephones, that are continuously attached in order to receive and send voice at any time. A cellular network also may include a cellular data service, such as a General Packet Radio Service ("GPRS"), for receiving and sending data to devices in the network.

However, when a cellular device is continuously attached to the cellular data service, significant cellular network resources are consumed. For example, a cellular device that is attached to the cellular data service may use a public IP address, a port and

cellular network bandwidth whether or not data is actually being transferred to or form the cellular device.

Moreover, a cellular device may also be included in a short distance wireless network that includes a plurality of terminals. These terminals may or may not require access to the cellular data service. For example, one terminal may not need access to the cellular data service, such as the headset; while a second terminal, such as a messaging terminal may only need intermittent access to the cellular data service. Thus, even though the cellular device is included in a short distance wireless network that may need to transfer data to and from the cellular network, continuously attaching the cellular device to the cellular data service will likewise unnecessarily consume network resources when terminals do not need access to cellular data service.

Therefore, it is desirable to provide a device, system, method and computer readable medium that does not unnecessarily consume network resources.

Summary Of The Invention

A device, method, system and computer readable medium allows for selectively attaching to a cellular data service to a short distance wireless network.

In an embodiment of the present invention, a device, such as a cellular telephone, includes a processor and memory to store a software component for selectively attaching to a cellular data service to a short distance wireless network responsive to a terminal in the short distance wireless network communicating with the device.

In an embodiment of the present invention, the communicating includes identifying the type of terminal, the terminal generating a message to the device, the terminal requesting a private IP address or the terminal requesting cellular data service from the cellular network.

In an embodiment of the present invention, the selectively attaching includes establishing a short-range LAN access profile or dial-up network session.

In an embodiment of the present invention, the software component terminates the attachment after a predetermined period of time, after the device has not received a data

packet for the terminal or generated a data packet from the terminal in a predetermined period of time, or the terminal generates a terminate message to the device.

In an alternate embodiment of the present invention, cellular data service is selectively attached to a short distance wireless network responsive to a device communicating with multiple terminals.

According to an embodiment of the present invention, the short distance wireless network is a Bluetooth™ wireless local area network or an 802.11 wireless local area network.

A method for communicating with a cellular network is provided in an embodiment of the present invention. A terminal in the short distance wireless network generates a short-range radio message. A device receives the short-range radio message. The device generates a cellular signal requesting a public IP address from a cellular data service responsive to the short-range radio message. The device receives a cellular signal containing the public IP address for the device. The device transfers a plurality of IP packets between the terminal and the cellular network using the public IP address.

A system for providing communication between a cellular data service in a cellular network and a short distance wireless network is provided in an embodiment of the present invention. A hand-held wireless device includes a cellular transceiver to communicate with the cellular network and receive an IP address responsive to requesting a cellular data service for the hand-held wireless device and a short-range transceiver to communicate with the short-range radio network. A hand-held memory is coupled to the cellular and short-range radio transceivers and stores a software component to selectively transfer a plurality of packets responsive to a short-range radio message generated by a first wireless device.

According to an embodiment of the present invention, the first wireless device is selected from a group consisting of a desktop computer, a laptop computer, a personal digital assistant, a headset, a pager, a pen, a printer, a watch, a digital camera and an equivalent.

According to an embodiment of the present invention, the hand-held wireless device uses a protocol selected from a group consisting of GSM, Code Division Multiple Access ("CDMA"), CDMA2000, Universal Mobile Telecommunications System ("UMTS"), Time Division Multiple Access ("TDMA") and an equivalent to communicate with the wide area network.

An article of manufacture, including a computer readable medium, is provided in another embodiment of the present invention. A short-range radio software component provides a short-range radio signal in a short distance wireless network. A cellular software component provides a communication signal in a wide area network. A software component selectively transfers a plurality of packets, using a cellular data network address, between the cellular data network and the short distance wireless network responsive to a short-range radio message requesting service in the cellular network

Other aspects and advantages of the present invention can be seen upon review of the figures, the detailed description, and the claims that follow.

Brief Description Of The Figures

Fig. 1 illustrates a system according to an embodiment of the present invention.

Fig. 2 illustrates thin terminals and a wireless device according to an embodiment of the present invention.

Figs. 3a-b are hardware block diagrams of a wireless device and a wireless hand-held device according to an embodiment of the present invention.

Figs. 4-7 are software block diagrams for a wireless device according to an embodiment of the present invention.

Fig. 8 is a software block diagram of manager software in manager server 102 illustrated in Fig. 1 according to an embodiment of the present invention.

Figs. 9a-9d are flowcharts of methods according to embodiments of the present invention.

Detailed Description

I. System Overview

The following description and claims relate to a device, method, system, and computer readable medium for selectively attaching a short distance wireless network to a cellular network, and in particular a cellular data service. In an embodiment of the present invention, a device 106 includes cellular network connection software component 600 that selectively attaches terminals 107 in short distance wireless network 116 to WAN 105, and in particular cellular network 129 having cellular data services 129a, shown in Fig. 1. Cellular network connection software component 600 selectively enables the transfer of data between a terminal in short distance wireless network 116 and a component in WAN 105, such as server 101, in response to one or more terminal messages from one or more terminals, respectively. In an embodiment of the present invention, the terminal message includes identifying the type of the terminal, requesting a private IP address for the terminal or the terminal requesting a cellular data service from cellular network 129. The cellular network connection software component 600 also terminates the attachment. Thus, cellular network 129 resources are preserved and used when needed.

In an embodiment of the present invention, a short distance wireless network is a network of processing devices, such as a personal computer or headset, that span a relatively small physical area, wherein at least one device generates and receives a short-range radio signal for communicating with another device in the network. In an embodiment of the present invention, a short-range radio signal can travel between approximately 0 and approximately 1000 feet. An example of a short distance wireless network includes a network of devices formed by Bluetooth™, HomeRF, 802.11 technologies, or an equivalent, singly or in combination. In an embodiment of the present invention, each processing device in a short distance wireless network has its own processing unit that executes a software component stored on the processing device memory, but also may access data and devices on the short distance wireless network. In an embodiment of the present invention, a wire, and in particular an Ethernet, provides

communication between two or more processing devices in a short distance wireless network. In an alternate embodiment, electromagnetic signals provide wireless communication between one or more processing devices in a short distance wireless network. In still another embodiment, both wires and electromagnetic signals provide communication between processing devices in a short distance wireless network.

In an embodiment of the present invention, a WAN includes multiple local area networks ("LANs") and/or short distance wireless networks connected over a relatively large distance. Telephone lines and electromagnetic signals, singly or in combination, couple the LANs and/or short distance wireless networks in a WAN. In an embodiment of the present invention, WAN 105 includes a cellular network 129 generating and receiving cellular signals 111. In an embodiment of the present invention, cellular network 129 includes a cellular data service, such as GPRS, for providing data packets. In an embodiment of the present invention, a cellular network is defined as a communication system dividing a geographic region into sections, called cells. In an analog embodiment of the present invention, the purpose of this division is to make the most use out of a limited number of transmission frequencies. In an analog embodiment of the present invention, each connection, or for example conversation, requires its own dedicated frequency, and the total number of available frequencies is about 1,000. To support more than 1,000 simultaneous conversations, cellular systems allocate a set number of frequencies for each cell. Two cells can use the same frequency for different conversations so long as the cells are not adjacent to each other.

Fig. 1 illustrates system 100 according to an embodiment of the present invention. System 100 includes other devices or terminals 107 coupled to wireless device 106. In an embodiment of the present invention, device 106 and one or more terminals 107 communicate to form a short distance wireless network 116. In an embodiment of the present invention, terminals 107 are coupled to device 106 by short-range radio signals 110 to form short distance wireless network 116. In an embodiment of the present invention, some or all of terminals 107 may have wired connections. In an embodiment of the present invention, terminals 107 include a watch 107a, PDA 107b, headset 107c

and laptop computer 107d that generate respective output signals. In an alternate embodiment, fewer or more terminals are used in short distance wireless network 116. In an alternate embodiment, terminals 107 include a desktop computer, a pager, a pen, a printer, a watch, a thin terminal, a messaging terminal, a digital camera or an equivalent. In an embodiment of the present invention, terminals 107 include a Bluetooth™ 2.4 GHz transceiver. Likewise, device 106 includes a Bluetooth™ 2.4 GHZ transceiver. In an alternate embodiment of the present invention, a Bluetooth™ 5.7 GHZ transceiver is used. Hardware for device 106 and terminals 107 are illustrated in Figs. 3a-b in an embodiment of the present invention.

In alternate embodiments of the present invention, other local wireless technologies, such as 802.11 or HomeRF signals, are used to communicate between device 106 and terminals 107.

In an embodiment of the present invention, WAN 105 is coupled to device 106. In an embodiment of the present invention, WAN 105 includes a cellular network 129 transmitting and receiving cellular signals 111. In an embodiment of the present invention, cellular signals 111 are transmitted using a protocol, such as a GSM protocol with a GPRS. In alternate embodiments, a Code Division Multiple Access ("CDMA"), CDMA 2000, Universal Mobile Telecommunications System ("UMTS"), Time Division Multiple Access ("TDMA"), or 3G protocols or an equivalent is used.

In an embodiment of the present invention, WAN 105 includes carrier backbone 104, servers 101-102 and Internet 103. In an embodiment of the present invention, IP packets are transferred between the components illustrated in Fig. 1. In alternate embodiments of the present invention, other packet types are transferred between the components illustrated in Fig. 1. In an embodiment of the present invention, a packet includes predetermined fields of information, such as header field and data field. A header field may include information necessary in transferring the packet, such as a source IP address.

In an embodiment of the present invention, WAN 105 includes an IP public or private network, such as a corporate secured network using a Virtual Private Network ("VPN").

In an alternate embodiment of the present invention, device 106 is coupled to WAN 105 by an Ethernet, Digital Subscriber Line ("DSL"), or cable modem connection, singly or in combination.

In an embodiment of the present invention, device 106 is a cellular handset or telephone. In an alternate embodiment of the present invention, device 106 is a cellular enabled PDA, wireless modem and/or wireless laptop computer.

In an embodiment of the present invention, WAN 105 is coupled to a wireless carrier internal network or carrier backbone 104. In an embodiment of the present invention, server 102 is coupled to carrier backbone 104. In an alternate embodiment of the present invention, carrier backbone 104 is coupled to Internet 103. Server 101 is coupled to Internet 103. In an embodiment of the present invention, servers 101 and 102 provide information, such as web pages or application software components, to terminals 107 by way of device 106. In an embodiment of the present invention, manager server 102 provides a microrouter 404 and/or network service plug-ins 406a-k to device 106, as described below. Further, manager server 102, monitors applications and terminals in a short distance wireless network 116. In an embodiment of the present invention, terminals 107 share services and communicate by way of device 106.

In an embodiment of the present invention, one or more terminals in short distance wireless network 116 accesses information and/or services from server 101. In an embodiment of the present invention, server 101 provides device 106 with a public IP address to allow for devices in short distance wireless network 116 to communicate, by way of a TCP/IP protocol connection, with server 101. In an alternate embodiment, server 101 is a termination point for a session initiated by device 106 (or terminals 107) and an alternate address server provides public IP address to device 106.

II. Hand-held Device/Terminal Hardware

Fig. 2 illustrates embodiments of terminals 107 and device 106. In an embodiment of the present invention, there are two types of terminals: 1) smart terminals and 2) thin terminals. In an alternate embodiment of the present invention, smart terminals execute user logic and applications. Smart terminals have a relatively powerful processing unit, operating system and applications. Their main needs from a short distance wireless network 116 are access to a WAN 105 through TCP/IP and other network services such as storage and execution. For example, a laptop computer 107d and PDA 107b are smart terminals. Thin terminals have a relatively low power processing unit and operating system. They are mainly used as peripherals to an application server in a short distance wireless network 116 and their main task is user interaction, rendering output for a user and providing an application server with a user's input. For example, a watch 107a or messaging terminals can be thin terminals.

Fig. 2 illustrates thin terminals. Voice terminal 204 includes a display 204b and a retractable keypad 204a. Messaging Terminal 203 is illustrated in a closed position with a hinge 203a used to open and close terminal 203. Terminal 203 also includes a miniature QWERTY keyboard and display when opened.

In an embodiment of the present invention, device 201 is a cellular modem and includes a clip 202 for a belt.

Fig. 3a illustrates a hardware block diagram of device 106 in an embodiment of the present invention. Device 106 includes both internal and removable memory. In particular, device 106 includes internal FLASH (or Electrically Erasable Programmable Read-Only Memory ("EEPROM") and Static Random Access Memory ("SRAM") 302 and 303, respectively. Removable FLASH memory 304 is also used in an embodiment of the present invention. Memories 302, 303, and 304 are coupled to bus 305. In an embodiment of the present invention, bus 305 is an address and data bus. Application processor 301 is likewise coupled to bus 305. In an embodiment of the present invention, processor 301 is a 32-bit processor.

Bluetooth™ processor 307 is also coupled to bus 305. Bluetooth™ RF circuit 309 is coupled to Bluetooth™ processor 307 and antenna 313. Processor 307, RF circuit 309 and antenna 313 transmit and receive short-range radio signals to and from terminals 107, illustrated in Fig. 1, or device 350, illustrated in Fig. 3b.

Cellular, such as GSM, signals are transmitted and received using digital circuit 306, analog circuit 308, transmitter 310, receiver 311 and antenna 312. Digital circuit 306 is coupled to bus 305. In alternate embodiments, device 106 includes a display, a speaker, a microphone, a keypad and a touchscreen, singly or in combination.

In a preferred embodiment of the present invention, device 106 has a dual bus architecture where a first processor is coupled to a cellular transceiver by a first bus and a second processor is coupled to a short-range transceiver by a second bus. In an embodiment, a third bus couples the first and second processors.

Fig. 3b illustrates device 350 that is a hand-held device in an embodiment of the present invention. Device 350, in an embodiment of the present invention, is one of the terminals 107 illustrated in Fig. 1. Similar to device 106, device 350 includes SRAM and FLASH memory 351 and 352, respectively. Memories 351 and 352 are coupled to bus 357. In an embodiment of the present invention, bus 357 is an address and data bus. Keypad 353 is also coupled to bus 357. Short-range radio signals are transmitted and received using Bluetooth™ processor 354 and Bluetooth™ RF circuit 355. Antenna 356 is coupled to Bluetooth™ RF circuit 355. In an embodiment of the present invention, antenna 356 transmits and receives short-range radio signals. In alternate embodiments, device 350 includes a display, a speaker, a microphone, a keypad and a touchscreen, singly or in combination. As one of ordinary skill in the art would appreciate, other hardware components would be provided for device 350 in alternate embodiments of the present invention. For example in an embodiment in which device 350 is a laptop computer 107d, a disk drive and other input/output components are present.

In a preferred embodiment of the present invention, device 350 likewise has a dual bus architecture where a first processor is a first bus and a second processor is

coupled to a short-range transceiver by a second bus. In an embodiment, a third bus couples the first and second processors.

III. Software

Fig. 4 illustrates a software architecture 500 for device 106 illustrated in Fig. 3a according to an embodiment of the present invention. In an embodiment of the present invention, software 500 is stored in FLASH memory 302. In an embodiment of the present invention, software components referenced in Figs. 4-8 represent a software program, a software object, a software function, a software subroutine, a software method, a software instance, and a code fragment, singly or in combination. In an alternate embodiment, functions performed by software components illustrated in Figs. 4-8 are carried out completely or partially by hardware.

In an embodiment of the present invention, software 500, or components of software 500, is stored in an article of manufacture, such as a computer readable medium. For example, software 500 is stored in a magnetic hard disk, an optical disk, a floppy disk, Compact Disk Read-Only Memory ("CD-ROM"), Random Access Memory ("RAM"), Read-Only Memory ("ROM"), or other readable or writeable data storage technologies, singly or in combination. In yet another embodiment, software 500, or components thereof, is downloaded from manager server 102 illustrated in Fig. 1.

Software 500 includes telecommunication software or physical layer protocol stacks, in particular cellular communication software 503 and short-range radio communication software 502. In an embodiment, communication software 503 is a GPRS baseband software component used with processor 306 to transmit and receive cellular signals including data packets. In an embodiment, communication software 502 is a Bluetooth™ baseband software component used with processor 307 to transmit and receive short-range radio signals. Other telecommunication software may be used as illustrated by other basebands 501.

In an embodiment of the present invention, operating system ("OS") 403 is used to communicate with telecommunication software 502 and 503. In an embodiment of the

present invention, operating system 403 is a Linux operating system, EPOC operating system available from Symbian software of London, United Kingdom or a PocketPC or a Stinger operating system available from Microsoft® Corporation of Redmond, Washington or Nucleus operating system, available from Accelerated Technology, Inc. of Mobile, Alabama. Operating system 403 manages hardware and enables execution space for device software components.

Media abstraction layer 504 allows operating system 403 to communicate with basebands 503, 502 and 501, respectively. Media abstraction layer 504 and other abstraction layers, described herein, translate a particular communication protocol, such as GPRS, into a standard command set used by a device and/or terminal. The purpose of an abstraction layer is to isolate the physical stacks from the rest of the device software components. This enables future usage of different physical stacks without changing any of the upper layer software and allows the device software to work with any communication protocol.

Furthermore, Graphics User Interface ("GUI") 407 is provided to allow a user-friendly interface.

Microrouter 404 and network service plug-in 406 enables an IP based network or enhanced IP based network, respectfully.

A. Microrouter

Microrouter 404 enables an IP based network between device 106 and terminals 107. In an embodiment of the present invention, each terminal can leverage the existing IP protocol, exchange information with other terminals and gain access to a WAN through microrouter 404. Extended network services, such as network service plug-ins 406, may be added to microrouter 404. In an embodiment, manager server 102, installs microrouter 404 and network service plug-ins 406 on device 106.

Fig. 5 illustrates software components of microrouter 404. In an embodiment of the present invention, routing software component 550, Bluetooth™ LAN Access Profile software component 551, Point-to-Point Protocol ("PPP") software component 552 and

Network Address Translator ("NAT") software component 553 are included in microrouter 404. In an alternate embodiment, other software components, such as packet filters 562, Bluetooth™ filters 560, scheduling 563 and IP client 561 are included in microrouter 404. In still another embodiment, microrouter 404 includes hooks 590 for adding network services plug-ins 406.

1. Microrouter services

In an embodiment, microrouter 404 services include software components for a short distance wireless network that has access to a WAN. In an embodiment, the software components included in a microrouter 404 are described below.

a. Bluetooth™ Access Profile ("BAP")

BAP software component 551 enables Bluetooth™ terminals to gain access to short distance wireless network 116 and a WAN by using an IP protocol.

In an embodiment of the present invention, BAP 551 includes implementation of two Bluetooth™ usage profiles such as: 1) Bluetooth™ LAN Access Profile software and 2) Bluetooth™ Dial-Up Profile software.

Bluetooth™ LAN Access Profile software component allows a LAN Access client in a terminal to obtain an private IP address and use the private IP address in order to gain connectivity to other short distance wireless network terminals or to a WAN, behaving as if they were on a short distance wireless network.

Bluetooth™ Dial-Up Profile software component enables a terminal to dial-up to any termination number and get IP services from that termination. In addition, a Bluetooth™ Dial-Up Profile ("DUP") software component emulates termination in device 106. In an embodiment, microrouter 404 has either a Bluetooth™ LAN Access Profile software component or a Bluetooth™ Dial-Up Profile software component. In an alternate embodiment, microrouter 404 includes both Profile software components. In a Bluetooth™ Dial-Up Profile software component mode, a terminal dials a predefined number, for example 999, for which microrouter 404 will not actually dial the number

over a cellular network, but emulates as if the number was dialed and a modem answered the call. Microrouter 404 will provide the terminal with an IP address and access to WAN 105. From the terminal's point of view it is as if the terminal dialed a number 999 to a modem and received an IP service from that modem, but in reality the terminal used DUP to obtain packet switching access to WAN 105 and the call was actually terminated at microrouter 404.

b. Routing

Routing software component 550 is responsible for transferring IP packets either in a short distance wireless network or toward a WAN. In a short distance wireless network 116, Routing software component 550 handles broadcasting IP packets and transferring IP packets between terminals. Routing 550 is also responsible for LAN IP Broadcast emulation.

Routing software component 550 is responsible for IP packet queuing/dropping. An IP packet dropping software component is used for reducing congestion caused by having more than one terminal connected simultaneously. In an embodiment of the present invention, Routing software component 550 includes a queuing software component, Quality of Service software component or equivalent for queuing IP packets. Likewise, Routing software component 550 includes a dropping software component that is configured by manager server 102, a user or any other remote entity. In an embodiment of the present invention, manager server 102 defines and loads an IP packet queuing/dropping software component. An operator 115 will be able to define a particular queuing/dropping software component that is suitable for a particular short distance wireless network 116 or user. A user will have a better short distance wireless network 116, and thus a better user experience, without having to configure or monitor a short distance wireless network 116.

In an alternate embodiment of the present invention, Routing software component 550 is a bridge software component for transferring an IP address.

c. PPP

In an embodiment of the present invention, microrouter 404 includes a PPP software component 552, such as a PPP server that is the termination for a short distance wireless network access profile software component. A PPP server provides IP network information, such as a private IP address, DNS address or the like, to a terminal.

d. NAT

NAT software component 553 is used 1) because only one public IP address or WAN IP source address is typically made available to a cellular telephone and 2) in order to conserve public IP addresses provided by an operator. In an embodiment of the present invention, WAN 105, and in particular, a cellular packet switching network 129, provides device 106 with one public WAN IP address. A short distance wireless network 116 however includes more than one participating terminal. In order to provide IP addresses to all terminals 107, private short distance wireless network IP addresses will be used for short distance wireless network terminals while NAT 553 is responsible for translations between private short distance wireless network IP addresses and public WAN IP addresses, and vice versa.

e. GPRS Profile

GPRS profile software component 555 is responsible for obtaining IP packets in a GPRS format received by device 106 by way of cellular network 129, and in particular cellular data service 129a, and providing the received IP packets to routing software component 555 for transfer to one or more terminals 107 and/or device 106. Likewise, GPRS software profile software component 555 is responsible for preparing IP packets from one or more terminals 107 and/or device 106 for transferring to a cellular data service 129a. GPRS profile software component 555 is also responsible for attaching, or obtaining a public IP address for device 106, from cellular data service 129a in response to a control signal. Similarly, GPRS profile software component 555 is also responsible

for disconnecting, or releasing a previously assigned public IP address, to cellular data service 129a responsive to a control signal.

f. Cellular Network Connection

In an embodiment of the present invention, cellular network attachment software component 600 is included in NAT software component 553 as illustrated in Figs. 5a and 6. In an alternate embodiment of the present invention, cellular network attachment software component 750 is included in Routing software component 550 as illustrated in Fig. 5b. In still another embodiment, cellular network attachment software component 800 is a separate software component and not included in either NAT software component 553 or Routing software component 550. As one of ordinary skill in the art would appreciate, the functions of cellular network attachment software component 600, 750 and 800 are included, singly or in combination, in other software components of microrouter 404 and/or software architecture 500 in alternate embodiments of the present invention.

Arrows shown in Figs. 5a-b and 7 represent flow of data and/or control signals between software components. In alternate embodiments of the present invention, software components shown in Figs. 5a-b and 7 communicate by reading values in memory locations or generate/receive a message that is represented by the arrows. For example, the arrow from NAT 553 to DHCP/PPP 552 represents a termination message generated by cellular network attachment software component 600 to terminate a PPP connection between a selected connected terminals and a component in WAN 105. As one of ordinary skill in the art would appreciate, more or less communication of data and/or control or arrows between software components may be used in alternate embodiments of the present invention.

Cellular network attachment software components 600, 750 and 800 are responsible for selectively attaching to cellular data service 129a or allowing for the transfer of data packets between WAN 105, specifically cellular network 129, and one or more terminals 107 in short distance wireless network 116.

In an embodiment of the present invention, cellular network attachment software component 600, 750 and 800 attaches to cellular data service 129a responsive to the types of terminals present or activated in short distance wireless network 116. For example, if headset 107c, which does not require access to cellular data service 129a, is the powered on and is the only terminal in short distance wireless network 116, cellular network attachment software components 600, 750 or 800 do not attach to cellular data service 129a. In contrast, if PDA 107b having a web browser is powered on and becomes a part of short distance wireless network 116, cellular network attachment software components 600, 750 or 800 attaches to cellular data service 129a and thereby allows for the transfer of data packets between PDA 107b and cellular network 129.

In an alternate embodiment of the present invention, cellular network attachment software components 600, 750 and 800 attaches to cellular data service 129a when a terminal generates a short-range radio signal message to device 106. For example, PDA 107b may generate a message that identifys PDA 107b as a terminal requiring cellular data service. In another example, a terminal may generate only a short-range radio signal that informs device 106 that the terminal is activated. In still another example, a terminal may generate a message requesting cellular data service from WAN 105 or request a private IP address.

In embodiments of the present invention, cellular network attachment software components 600, 750 and 800 cause a short-range LAN access profile connection or a dial-up connection with the terminal to be connected to WAN 105.

In an embodiment of the present invention, cellular attachment software components 600, 750 and 800 are responsible for detaching a terminal and WAN 105, and in particular cellular data services 129a. In an embodiment of the present invention, cellular attachment software components 600, 750 and 800 attaches or detaches to or from cellular data service 129a responsive to a plurality of messages from a respective plurality of terminals. As long as at least one terminal requests or needs a cellular data service, cellular attachment software components 600, 750 and 800 will remain attached to cellular data service 129a

Fig. 5a illustrates an embodiment of the present invention in which cellular network attachment software component 600 is included in NAT 553. Cellular network attachment software component 600 generates an attach control signal to GPRS Profile software component 555 responsive to a determination that a terminal is to be connected to WAN 105. Likewise, cellular attachment software component 600 generates a detach signal to GPRS Profile software component 555 when a determination that a terminal is to be detached from cellular data service 129a. Cellular network software component 600 generates an attach or detach signal responsive to a short-range radio message obtained from one or more terminals 107, by way of BAP 551.Fig. 6 illustrates a detailed view of cellular attachment software component 600 including cellular network attachment logic 601, memory location for public IP address 603 and table 602. In an embodiment of the present invention, cellular network attachment logic 601 is responsible for making determination as to whether to generate a attach or detach control signal. For example, cellular network attachment logic 601 reads table 602 to determine whether a particular terminal has generated a message, requested a private IP address, requested a data service from a cellular network or has identified as requiring a cellular data service.

Table 602, stored in a plurality of memory locations, includes a list of active terminals in short distance wireless network 116 shown in column 602a, corresponding assigned private IP addresses for the terminals seen in column 602b and corresponding cellular data service access field values seen in column 602c. For example, according to table 602, PDA 107b has an assigned private IP address of 10.10.10.11 and requires access to cellular data service 129a as indicated by the "yes" value. In contrast table 602 shows, that headset 107c does not have a private IP address and does not require access to cellular data service 129a as indicated by the "no" value. In an embodiment of the present invention, cellular network attachment logic 601 writes and reads to fields in column 602c responsive to one or more terminal messages in short-range radio signals 110.

Cellular network attachment logic 601 maintains an attachment to cellular data services 129a when one or more terminals are attached and yet a first terminal is to be detached.

Cellular network attachment logic 601 also includes a timing logic and access to queued data packets from and to WAN 105 in Routing 550 to determine whether to attach a particular terminal.

A public IP address assigned by a component in WAN 105, such as server 101, is obtained by device 106 and stored in memory location 603. The public IP address is then associated with one or more terminals in short distance wireless network 116 as represented by table 602.

Fig. 5b illustrates a similar embodiment of the present invention. Cellular network attachment software component 750 is included in Routing software component 550. In this embodiment, cellular network attachment logic 601 is included in Routing software component 550 in order to access queued data packets for respective terminals. Cellular attachment logic 601 in cellular network attachment software component 750 also has access to a table identifying private IP addresses and/or cellular data service access fields in NAT software component 553. In still a further embodiment, a first table including activated terminals and respective cellular data service access field values is stored in cellular attachment software component 750 and a second table including private IP addresses for activated terminals is stored in NAT 553.

Fig. 7 illustrates another embodiment in which cellular network attachment software component 800 is a separate software component and transfers data and control signals to and from GPRS Profile 555, DHCP/PPP 552, Routing 550, NAT 553 and BAP 551 software components.

Figs. 9a-d illustrate methods 900a-d for attaching a cellular data service in WAN 105 and short distance wireless network 116 according to an embodiment of the present invention. In an embodiment, a method is performed, in part or completely, by software components illustrated in Figs. 4-7. In an embodiment of the present invention, a logic block or step illustrated in Figs. 9a-d may represent an execution of a software

component, such as a software program, a software object, a software function, a software subroutine, a software method, a software instance, a code fragment singly or in combination. In an alternate embodiment of the present invention, logic block or step represents execution of a software component, hardware operation, or user operation, singly or in combination. In an alternate embodiment of the present invention, fewer or more logic blocks or steps are carried out in the methods illustrated in Figs. 9a-d.

Fig. 9a illustrates method 900a for selectively attaching cellular data service 129a in WAN 105 to a terminal in short distance wireless network 116 according to an embodiment of the present invention. Method 900a begins by determining the types of terminals in a short distance wireless network. For example, a terminal may generate a short-range radio message to device 106 identifying whether the terminal is a PDA having a web browser that requires access. A determination is then made whether there are any terminals in a short distance wireless network that require access to a cellular network, as illustrated by logic block 902. In an embodiment of the present invention, cellular attachment software component 600 reads a value from column 602c in table 602 shown in Fig. 6. If no terminal needs access to a cellular data service, method 900a ends. Otherwise, a cellular network attachment is established between the terminal requiring cellular data service and WAN 105, by way of device 106, as illustrated by logic block 903.

In an embodiment of the present invention, the terminal in short distance wireless network 116 then establishes a TCP/IP connection to server 101 by way of device 106. A TCP/IP connection is established by using a stored public IP address provided by server 101 and stored in memory location 603 as seen in Fig. 6. Thus, a plurality of IP packets are transferred between server 101 and the terminal needing access to cellular data services129a in WAN 105. In alternate embodiments of the present invention, other communication connections are established between the terminal and components of in WAN 105.

In logic block 904, a determination is made whether the attachment between the terminal and cellular data services 129a should be detached. In an embodiment of the

present invention, cellular network attachment software component 600 generates a detach control signal to GPRS profile software component 555 responsive to receiving short-range radio messages from one or more terminals, by way of BAP software component 551. If a determination is made to detach, control passes to logic block 905 where cellular data service 129a is detached and method 900a ends.

Fig. 9b illustrates method 900b for selectively attaching a cellular data service 129a in WAN 105 to a terminal in short distance wireless network 116 according to an embodiment of the present invention. Method 900b begins by determining whether device 106 has received a short-range radio message from any of the terminals in a short distance wireless network 116. For example, a terminal may generate a short-range radio message to device 106 in order to pair to device 106 and form short distance wireless network 116, as illustrated by logic block 911. If a short-range radio message is received from a terminal, a cellular data service attachment is established between the terminal that generated the message and cellular data service 129a in WAN 105, by way of device 106, as illustrated by logic block 912. The attachment is established as described above in regard to method 900a in an embodiment of the present invention. In logic block 913, a determination is made whether the attachment between the terminal and WAN 105 should be detached. If a determination is made to detach, logic passes to logic block 914 where the terminal is detached and method 900b ends. The terminal is detached as described above in regard to method 900a in an embodiment of the present invention.

Fig. 9c illustrates method 900c for selectively attaching cellular data service 129a in WAN 105 to a terminal in short distance wireless network 116 according to an embodiment of the present invention. Method 900c begins by determining whether device 106 has received a short-range radio message from any of the terminals in a short distance wireless network 116, as illustrated by logic block 931. If a short-range radio message is received from a terminal, control passes to logic block 932 where a determination is made whether the message contains a request for a data service in WAN 105. If a terminal makes a request for a data service, control passes to logic block 933 where an attachment is established as described above in regard to method 900a in an

embodiment of the present invention. In logic block 934, a determination is made whether the attachment between the terminal requesting a data service and WAN 105 should be detached. If a determination is made to detach, control passes to logic block 935 where the terminal is detached and method 900c ends. The terminal is detached as described above in regard to method 900a in an embodiment of the present invention.

Fig. 9d illustrates method 900d for selectively attaching cellular data service 129a in WAN 105 to a terminal in short distance wireless network 116 according to an embodiment of the present invention. Method 900d begins by determining whether device 106 has received a short-range radio message from any of the terminals in a short distance wireless network 116, as illustrated by logic block 941. If a short-range radio message is received from a terminal, control passes to logic block 942 where a determination is made whether the message contains a request for a private IP address. If a terminal makes a request for a private IP address, control passes to logic block 943 where an attachment is established as described above in regard to method 900a in an embodiment of the present invention. In logic block 944, a determination is made whether the attachment between the terminal requesting private IP address and cellular data services 129a in WAN 105 should be detached. If a determination is made to detach, control passes to logic block 945 where the terminal is detached and method 900d ends. The terminal is detached as described above in regard to method 900a in an embodiment of the present invention.

In an alternate embodiment of the present invention, an application software component in device 106 requests a cellular data service and cellular network attachment software component 600, 700 or 800 allows for attaching and detaching to and from cellular data service 129a responsive to a request from the application software component in embodiments of the present invention. For example, watch 107a is a terminal that accesses a watch application software component on device 106. A watch application software component provides messages and/or information to watch 107a responsive to user interaction or short-range radio messages from watch 107a. A user may indirectly request cellular data service by a user entry at watch 107a or watch 107a

requests information from the corresponding watch application software component stored on device 106 that then initiates an attachment to cellular data service 129a in order to provide the requested information to watch 107a.

2. Hooks to Extended Network Service Plug-Ins

In an embodiment of the present invention, microrouter 404 includes hooks 590 allowing for the extension of microrouter 404 networking services, such as plug-ins 406. In an embodiment of the present invention, hooks 590 are application program interfaces ("API") for plug-ins 406.

In an embodiment of the present invention, microrouter 404 is programmed to have only basic network abilities and a very low footprint, or in other words require very little memory, for example 100K bytes, in order to be stored in a device 106, such as a cellular telephone. However, in some instances more network services will be needed. Further, operators may want the ability to add and sell network services after the device 106 is sold and in operation without user intervention. A user may be less likely to purchase a network service if the user has to return device 106 to the manufacturer or an inconvenient site.

For these and other reasons, the microrouter 404 includes hooks 590 that enable plug-ins 406 to be implemented in an embodiment of the present invention. This plug-in capability does not define a full execution environment but defines a small framework for implementing code, which can plug-in and extend microrouter 404 network services. In an embodiment of the present invention, hooks 590 are not a user application framework, plug-in code abilities are limited and serve only as an extension to network services.

Plug-ins 406 are fully activated by microrouter 404, which has full control over them in an embodiment of the present invention. In some sense, plug-ins are like a Dynamic Link Library ("DLL") that have a predetermined set of functions that a microrouter can call in order for them to realize the needed functionality.

Below describes software components included in hooks 590 for implementing plug-ins 406 according to an embodiment of the present invention. In an alternate

embodiment, other software components are included or replace illustrated software components in hooks 590. For example, software components implementing functionality used by all plug-ins 406, such as hooks for centralized configuration and backend connectivity, are included in hooks 590 in an embodiment of the present invention. These included software components in hooks 590 will save resources and allow for efficient operation.

a. Packet Filters

Packet filters software component 562 allows plug-ins 406 to process IP packets going either internally in a short distance wireless network 116 or externally to and from a WAN. By enabling plug-ins 406 to process IP packets, change any part of a packet, drop a packet or generate more packets, microrouter 404 is able to include multiple other added extended network services. For example, microrouter 404 is able to include a VPN, a firewall, tag packets, monitor packets and other extended network services described below. In an embodiment of the present invention, packet filters 562 is a data path for transferring IP packets that are accessible by plug-ins 406.

b. Bluetooth™ Filters

Bluetooth™ filters software component 560 enables plug-ins 406 to process Bluetooth™ information. In an embodiment, Bluetooth™ filters 560 processes a pairing request event and provides a PIN number. In an embodiment of the present invention, Bluetooth™ filters 560 enables added network services such as PIN management, denying access to a short distance wireless network 116 from a terminal, authenticating a terminal, pairing through an interactive voice response ("IVR") system or the Internet. In an embodiment of the present invention, a Bluetooth™ filter 560 is a data path for transferring Bluetooth™ information that is accessible by plug-ins 406.

c. Scheduling

In order for plug-ins 406 to be able to generate events, traffic or do periodic tasks, a scheduling software component 563 enables a plug-in to receive a callback periodically or when required by the plug-in. For example, Scheduling software component 563 enables a statistics plug-in to send statistic information on terminal and application usage every X hours or calculate average traffic at a selected terminal.

d. IP Client

In an embodiment of the present invention, IP Client software component 561 makes available IP services to plug-ins 406 so a plug-in can obtain an IP address, send IP packets and/or receive IP packets. Thus, IP Client software component 561 enables a plug-in to obtain a private IP address from microrouter 404 and connect to a backend server, such as manager server 102. An IP client 561 can implement a TCP/IP stack or User Datagram Protocol ("UDP"). In an embodiment of the present invention, IP Client plug-in 561 uses all necessary microrouter 404 network services, such as packet filters 562 or NAT 553. From a microrouter 404 perspective, an IP Client 561 is treated like any other terminal on a short distance wireless network 116.

3. Plug-In Loader

A plug-in can be attached to a microrouter 404 during or after manufacturing. In an embodiment of the present invention, a plug-in is stored or programmed in device 106 before shipping from a manufacturer. Alternately, a plug-in is downloaded from manager server 102 at run-time over WAN 105.

A Plug-In Loader software component 554, as illustrated in Fig. 5, is responsible for loading plug-ins 406, programming of plug-ins 406 and notification of newly available plug-ins 406 to microrouter 404 in an embodiment of the present invention.

In an embodiment of the present invention, Plug-In Loader 554 will use operating system 403 capabilities for programming a file system and access of plug-ins 406. In an

alternate embodiment of the present invention, Plug-In Loader 554 uses a plug-in directory in a dedicated memory space of device106.

4. Microrouter Extended Service Plug-Ins

Below describes microrouter 404 extended service plug-ins 406 in an embodiment of the present invention. In various embodiments of the present invention, one or more of plug-ins 406 are attached to microrouter 404. In alternate embodiments, other plug-ins are attached to microrouter 404. In an embodiment of the present invention, a device manufacturer, terminal manufacturer, an operator 115 and/or other third party provides a plug-in.

a. Bluetooth™ Terminal Pairing Management ("BTPM")

BTPM software component plug-in 406a is responsible for PIN management and authenticating terminals for participating in a short distance wireless network 116. BTPM 406a allows an operator 115 to control which terminal can connect to a short distance wireless network 116. For example, an operator 115 can deny a terminal from pairing to a short distance wireless network 116, or can approve a terminal for pairing. In an embodiment of the present invention, pairing is done over an IVR, the Internet and/or by a user.

b. VPN

VPN software component plug-in 406b enables a secure link to a network, such as a private corporate network. VPN enables terminals to connect to a corporate file server, exchange server or an equivalent. VPN 406b uses packet filters 562 in order to identify packets that are routed to a corporate LAN IP subnet. In an embodiment of the present invention, VPN 406b then encrypts and tunnels the identified IP packets.

c. Firewall

Firewall software component plug-in 406c protects a short distance wireless network 116 from intruders and hackers. In an embodiment of the present invention, Firewall 406c uses packet filters 562 for identifying IP packets from non-authorized sources and IP packets that are sent to non-authorized servers. In an embodiment of the present invention, firewall 406c enables Uniform Resource Locator ("URL") filtering.

d. Statistics

In an embodiment of the present invention, Statistics software component plug-in 406d collects usage profiles and statistics on 1) which terminal in a short distance wireless network 116 is used, 2) how much traffic is generated by each terminal, and 3) how much traffic is generated by each application. Statistics 406d enables an operator 115 to promote used terminals and build billing schemes.

e. Link Optimizations

Implementing direct TCP/IP and Internet application protocols over WAN 105, and in particular a wireless network, produces poor performance because of low bandwidth, transmission delays and high data error rates. In order to solve the poor performance but still enable terminals to use standard TCP/IP, a Link Optimization software component plug-in 406e is provided. Link Optimization 406e traps all TCP/IP and specific Internet application protocols, such as Simple Mail Transfer Protocol ("SMTP") and Hypertext Transfer Protocol ("HTTP"), and converts the protocol to an optimized protocol. Link Optimization 406e then sends the converted packets to a backend server, such as manager server 102, which then deconverts the packets and sends them onto the Internet. In an embodiment of the present invention, terminals and users are not aware of using Link Optimization 406e.

f. Reverse firewall

As opposed to a typical LAN firewall that protects a short distance wireless network 116 from intruders and hackers from the Internet or another network, a Reverse Firewall ("RFW") software component plug-in 406g protects an operator 115 or another network from terminals and applications on a short distance wireless network 116 generating traffic toward those networks. RFW 406g enables an operator 115 or another entity to define and enforce usage policies for applications/terminals on a short distance wireless network 116. RFW 406g prevents unnecessary costly transmission costs. Enforcement of usage policies at the short distance wireless network level (i.e. at device 106) prevents expensive packets from going through a cellular network that will be eventually dropped. Further, packets that may be later dropped do not use the limited cellular transmission bandwidth.

In an embodiment of the present invention, RFW 406g is attached to a cellular handset that has Bluetooth™ capability for implementing a short distance wireless network 116 and GSM/GPRS for cellular access to a WAN 105 (i.e. Internet or any other network). RFW 406g is programmed to drop packets based on the originating terminal, originating application/terminal pair or original application. For example, if a user has a PDA and a Notebook, an operator 115 can configure for File Transfer Protocol ("FTP") packets from the PDA to be dropped if FTP from a PDA is not allowed, or for example to drop video streaming packets originated from the Notebook if video streaming is something the operator 115 does not allow.

Another example includes blocking Notebook usage of such software as Napster in order to avoid cellular unintended usage by users and associated cost.

g. Terminal Programming over Bluetooth™ ("TPB")

TPB software component plug-in 406f enables the programming of terminals 107 over Bluetooth™ and over a cellular network. In an embodiment of the present invention, programming a terminal is accomplished by "flashing" or programming EEPROM memory in a terminal. An operator 115 or manufacturer can transfer a flash image to be

flashed to device 106 having microrouter 404, and terminals 107 to be flashed. TPB 406f communicates with a Flashing software component in a terminal to 1) initiate the flashing process, 2) authenticate the flash image and 3) secure the flashing process.

In an embodiment of the present invention, flashing is done by transferring a full flash image. Alternatively, if there is not enough memory for the full flash image in device 106, the flash image is transferred block by block to eventually be flashed.

TPB 406f enables customizing a terminal, fixing software running on a terminal, and adding applications and/or improvements.

h. Short Message System ("SMS") Plug-In

SMS software component plug-in 406h allows terminals 107 to send messages between each other in a short distance wireless network 116. In an embodiment of the present invention, a terminal is a Messaging Terminal that enables Instant Messaging over IP. In an alternate embodiment of the present invention, SMS 406h enables standard legacy SMS or Instant Messaging over SMS.

In an embodiment of the present invention, SMS 406h is an SMS server for terminals 107 and an SMS termination for device 106. In this way, a protocol will be defined that enables each terminal to send a packet to SMS 406h with a destination device phone number + message text. SMS 406h then sends the SMS message to a cellular network.

SMS 406h also serves as an SMS receiver in an embodiment of the present invention. A terminal can inquire SMS 406h for received SMS messages and fetch those messages. In still another embodiment of the present invention, a terminal will also receive an IP broadcast message each time an SMS message is received by device 106.

i. Service Level Verification ("SLV")/Enforcement ("SLE")

SLV/SLE software component plug-in 406i enables an operator 115 to verify and enforce service level agreements with users. If an operator 115 wants to enforce service

levels, such as specifically limiting the amount of traffic over a cellular network, SLV/SLE 406i is added in order to avoid usage of expensive airtime.

In an embodiment of the present invention, SLV/SLE 406i allows a user to generate an unlimited amount of cellular traffic from device 106 during the night but a limited amount during the day. So during the day, if the limited amount is exceeded no more traffic can be generated from device 106 and packets are dropped by SLV/SLE 406i. Similar policies may likewise be enforced. SLV/SLE 406i also identifies and notifies operator 115 of missed cellular network usage by a particular user due to enforcement in an embodiment of the present invention.

j. Device Resources Access ("DRA")

DRA software component plug-in 406j enables terminals to gain access (according to defined restrictions) to device 106 resources. This enables a terminal to implement a Device Resources Access protocol over IP in order to gain access to any of the following resources: 1) phone book, 2) play a ring tone, 3) initiate a call, 4) user interface, or 5) other device resources.

DRA 406j enables a terminal to read/modify/add phone book entries in a phone book stored on device 106. In a preferred embodiment, a vCard format is used to exchange entry information between device 106 and terminals 107. This enables a better consistent experience for users. For example, DRA 406j provides a user immediate access to a device 106 phone book entries for sending a message from a messaging terminal without having to type the contact information from the phone book.

DRA 406j enables a user to be alerted by using a device 106 ring buzzer. Thus, a terminal in short distance wireless network 116 can use a device 106 ring buzzer for alerting a user.

DRA 406j enables a terminal, such as a PDA or an Outlook application on a notebook computer, to initiate a telephone call at device 106. In an embodiment of the present invention, clicking a phone icon near a phone number on a notebook display initiates a cellular telephone call.

Likewise, DRA 406j enables a terminal to interact with a user through device 106 menus and input components.

k. Terminal Management/Monitoring ("MNG")

MNG software component plug-in 406k enables management, configuration and monitoring of terminals 107 in an embodiment of the present invention. Instead of each terminal implementing a proprietary management protocol and console, each terminal exposes a "registry" of parameters and MNG 406k implements a protocol enabling a managing server 102 to browse this registry, get values and set values.

IV. Usage Scenarios

A. PDA Synchronizes Against The Corporate Exchange Server

In this scenario, a user is a traveling professional who has a PDA and needs to synchronize it against a corporate exchange server while on the road. This synchronization needs to be done securely as the only way to enter the corporate network is via a certified and Information Technology ("IT") manager approved VPN.

The user also has a cellular telephone having a microrouter 404 and VPN client 406j, which the IT manager installed. The IT manager used the remote management capabilities of the cellular telephone in order to configure a VPN to connect to the corporate network, as well as configured the firewall to block Internet access while the VPN is in use. The user is totally unaware of the VPN and its configurations.

As the user turns on the PDA, which is a Bluetooth™ equipped PDA with a LAN Access profile implementation, the PDA connects to the cellular telephone via the BAP 551 utilizing Bluetooth™. The PDA receives a private IP address.

The user loads the PDA synchronization software, which is configured to synchronize against the corporate exchange server. When hitting the "Synchronize" button, the PDA opens a TCP connection to the IP address of the corporate network.

The IP packets travel across the Bluetooth™ air interface to the cellular telephone using a PPP protocol and PPP 552. When reaching the cellular telephone, the packets go through NAT 553 and the private IP address is translated to a public IP address. The public IP address goes to VPN 406f, which identifies the destination as the corporate LAN. VPN 406f packages the packet over an Internet tunnel, encrypts and signs it. The packet is then sent through the cellular air interface and the Internet, reaching the corporate VPN and exchange servers. The PDA is totally unaware of this process.

B. PDA Synchronizes against a Notebook on the Short Distance Wireless Network

In this scenario, the user, as described above, needs to synchronize the PDA with a notebook computer.

The notebook has a Bluetooth™ card with a LAN access profile. Once the notebook is turned on, it connects to the user's cellular telephone having microrouter 404 and receives a private IP address.

The user runs the same synchronization software on his PDA, only this time chooses to synchronize with the notebook.

When hitting the "Synchronize" button on the PDA, the PDA opens a TCP connection to the notebook's IP address.

An IP packet travels, from the PDA, through the Bluetooth™ interface over a PPP protocol and reaches routing 550 in microrouter 404 that identifies the packet destined to a private IP address of the notebook. The IP packet is then sent to the notebook through the notebook's Bluetooth™ interface over a PPP protocol.

C. Web Pad Browsing the Internet

In this scenario, a user has a Web Pad equipped with a Bluetooth™ interface with a LAN access profile. The Web Pad is connected to the cellular telephone having microrouter 404, which is in the user's bag, and receives a private IP address through the LAN access profile. The Web Pad also has a web browser.

The user pulls out his Web Pad, goes to a URL line of the browser and types http://www.iximobile.com. The web browser first has to translate the name www.iximobile.com into a public IP address. This is done using a Domain Naming Service ("DNS") protocol. The Web Pad already received the private IP address of a DNS plug-in when it connected to the cellular telephone. The Web Pad sends a resolve request to the DNS plug-in software component in microrouter 404. DNS software component looks at its cache for the name. If the name is not available, the DNS plug-in software component goes to the next DNS on a WAN 105 to get the public IP address of the name. In both cases, the DNS eventually gets the public IP address for www.iximobile.com and sends the reply back to the Web Pad. In an embodiment of the present invention, a DNS software component is a plug-in 406 or a hook 590.

When the Web Pad receives the public IP address of the web site, it opens a TCP connection at port 80 of that public IP address in order to implement the HTTP protocol and get the HTML page to display.

V. Manager Server

In an embodiment of the present invention, Manager server 107, illustrated in Fig. 1, includes Manager software component 700 illustrated in Fig. 8. In an embodiment of the present invention, Manager software component 700 is used to load microrouter 404 and plug-ins 406 into device 106. In an additional embodiment of the present invention, Manager software 700 is used to manage, configure and collect data from short distance wireless network 116. In still another embodiment of the present invention, manager software 700 is not used with short distance wireless network 116.

Manager server 102 includes a Proliant server available from Compaq® Computer Corporation of Houston, Texas having a Windows® 2000 operating system available from Microsoft® Corporation in an embodiment of the present invention.

In an embodiment of the present invention, Manager software component 700 has an IP interface in order to gain access to microrouter 404 and access a device notification service, such as SMS 406h. Manager 700 can be installed on any network that has IP

connectivity to microrouter 404. Manager 700 can be installed by a service provider on Internet 103, or by an operator 115 on its IP backend network having server 102.

Manager software component 700 includes two software components, Network Manager software 701 and Extended Network Manager software 702, in an embodiment of the present invention.

Network Manager software 701 is responsible for, but not limited to, the following functions: 1) configuring an IP parameter, such as IP domain range or policies, 2) configuring plug-ins 406 currently installed and executed, 3) enabling/disabling an installed plug-ins 406, 4) loading new plug-ins in microrouter 404, and 5) removing plug-ins 406 from microrouter 404.

Network Extended Manager software 702 is responsible for, but not limited to, the following functions: 1) collecting usage profiles for each microrouter 404 and each terminal in short distance wireless network 116, 2) managing PINs, such as denying access to short distance wireless network 116 for a particular terminal or approving access to short distance wireless network 116 for other terminals, 3) managing security, such as configuring VPN 406b or configuring Firewall 406c, 4) configuring Link Optimization 406e, and 5) configuring Quality of Service ("QoS") parameters in microrouter 404.

In an embodiment of the present invention, Plug-In Manager software components 706a-f are stored in manager server 102 and use network manager software component 701 and/or Extended Network Manager software component 702 for accessing and controlling network plug-ins 406a-k. For example, a Plug-In Manager software component 706d is used to obtain statistics information from Statistics plug-in 406d in microrouter 404. In an embodiment of the present invention, there is a corresponding plug-in Manager software component in manager software 700 for every plug-in software component in microrouter 404.

VI. Conclusion

The foregoing description of the preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.